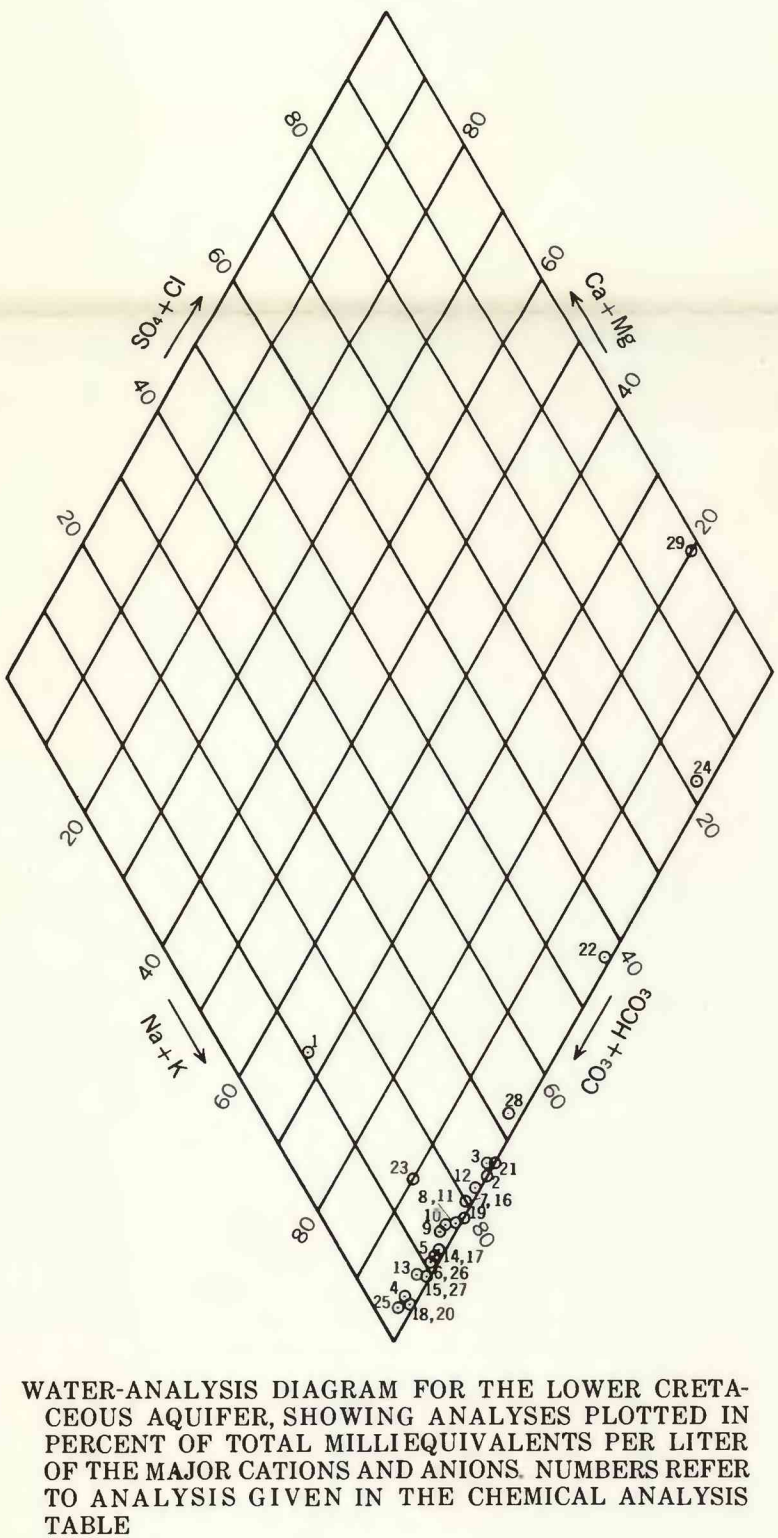


MAP OF DECLINE OF WATER LEVEL IN LOWER CRETACEOUS AQUIFER, FROM 1937-39 TO DECEMBER 1971

QUALITY OF GROUND WATER

Water being withdrawn from the Lower Cretaceous aquifer in the study area is excellent for domestic, municipal, and most industrial purposes. However, the chloride concentration of the water in the aquifer increases eastward and with depth. The lower sand beds in the eastern part of the area contain water relatively high in chloride. Although this high chloride water is not used it is a potential threat to the good quality water in the area immediately southeast of Franklin. Water from the Lower Cretaceous, except in the zone of high chloride water, is very soft and of the sodium bicarbonate type. Chemical character of water from wells tapping the Lower Cretaceous is shown in the chemical analysis table. Dissolved solids are low, ranging from about 200 to 400 mg/l (milligrams per liter) throughout most of the area, but may be more than 800 mg/l (well 58C1 near Suffolk). Concentrations of calcium, magnesium, potassium, and sulfate are low and cause no problems. Iron concentration is not more than 0.2 mg/l and is commonly less than 0.1 mg/l, except at Boykins, where it is 0.46 mg/l. The high sodium and bicarbonate concentrations may cause problems if the water is used for irrigation and for some industrial purposes, such as boiler feed water. The sodium content increases eastward. Observed values are 41 mg/l at Boykins, a range of 85 to 162 mg/l at Franklin, 208 mg/l at Lake Prince (well 57C15), and 313 mg/l near Suffolk (well 58C1). Bicarbonate also generally increases eastward—concentration is 186 mg/l at Boykins, 203–363 mg/l at Franklin, and 573 mg/l in water from well 58C1. Fluoride concentrations are high at Franklin and to the east and northeast, averaging 4 mg/l. Chloride concentration is low throughout most of the area, generally less than 35 mg/l.



Water in the Lower Cretaceous aquifer having a relatively high chloride concentration was noted by Cederstrom (1945), who reported water with as much as 100 mg/l chloride in Nansemond County along the James River, immediately northeast of the study area. A chemical analysis of a water sample from well 55B36 indicates 195 mg/l chloride 1 mile east of Franklin. The well has screens near the bottom of the Lower Cretaceous between 720 and 860 feet. Analyses of water from well 56A1, 7 miles southeast of Franklin, show a chloride content of 1,300 mg/l in the lowermost sand beds. A chloride content of 16,000 mg/l was found in water from the lowermost sand penetrated by well 58A2, about 20 miles southeast of Franklin. The chloride content of water from these wells and from well 57A1 near Whaleville has been used on section B-B' to define a zone where chloride concentration ranges from 1,300 to 16,000 mg/l. Additional water samples taken during development of wells 56A1 and 58A2 indicate that the chloride content of the water probably exceeds 250 mg/l between depths of 727 and 994 feet in well 56A1 and between depths of 730 and 1,879 feet in well 58A2. Water samples from the upper sand beds may not be representative of formation water; thus, the analyses are not included in the chemical analyses table. As few wells have been drilled deep enough to reach the zone of high chloride water, the boundary shown on section B-B' is only approximate.

On the diamond-shaped water-quality diagram, chemical analyses of water from the Lower Cretaceous are plotted

Chemical analyses of water from the Lower Cretaceous aquifer (results in milligrams per liter except temperature, specific conductance, and pH)

U.S. Geol. Survey well no.	Number used on diagram ¹	Owner	Interval sampled (feet below land surface)	Date of collection	Temperature (°C)	Dissolved silica (SiO ₂)	Iron (Fe)	Dissolved calcium (Ca)	Dissolved magnesium (Mg)	Dissolved sodium (Na)	Dissolved potassium (K)	Bicarbonate (HCO ₃)	Carbonate (CO ₃)	Dissolved sulfate (SO ₄)	Dissolved chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Phosphate (PO ₄)	Dissolved solids (residue at 180°C)	Hardness as CaCO ₃			Specific conductance (microhmhos at 25°C)	Laboratory pH
																				Calcium, magnesium	Non-carbonate			
53A3	1	Town of Boykins well 3	180–275	10–9–68	16.3	27	0.46	13	6.2	41	23	186	0	13	4.4	0.1	0.4	0.30	212	58	0	355	7.5	
54B1	2	Hercules Inc. well 2	370–600	10–9–68	18.0	30	.06	.2	.1	110	5.9	210	0	16	29	3.0	.3	3.3	300	1	0	500	8.0	
54B2	3	Hercules Inc. well 3	340–700	10–9–68	17.4	30	.03	.4	.1	102	5.9	203	0	16	30	2.5	.1	3.3	289	2	0	485	8.0	
55B1	4	Union Camp Corp. well 1a	380–590	9–27–68	18.2	24	.11	.4	.2	97	3.9	245	0	4.6	4.4	4.3	.3	3.0	269	0	0	400	8.2	
55B2	5	Union Camp Corp. well 2a	380–620	9–25–68	18.5	26	.18	.6	.2	108	3.9	256	0	8.0	15	4.1	.5	3.0	315	0	0	450	8.2	
55B3	6	Union Camp Corp. well 3	473–623	9–26–68	19.5	29	.05	.8	.1	95	3.1	226	0	8.0	11	4.5	.4	3.1	276	0	0	390	8.2	
55B4	7	Union Camp Corp. well 4	407–665	9–25–68	19	28	.18	.8	.1	131	4.7	280	0	15	32	3.5	.4	3.0	367	0	0	350	8.1	
55B5	8	Union Camp Corp. well 5	407–602	9–25–68	20	22	.09	.8	.1	153	5.9	339	0	15	30	4.0	.3	2.6	410	0	0	660	8.2	
55B6	9	Union Camp Corp. well 6	372–626	9–26–68	18.6	21	.06	.8	.5	162	6.6	354	5	14	28	4.0	.5	2.4	414	0	0	670	8.4	
55B7	10	Union Camp Corp. well 7	385–620	9–26–68	19.2	24	.05	.6	.4	153	5.5	339	2	16	28	3.9	.3	2.7	402	0	0	640	8.3	
55B9	11	Union Camp Corp. well 9	345–630	9–25–68	20	22	.14	1.0	.4	157	8.6	363	0	17	31	4.0	.0	2.5	432	0	0	705	8.2	
55B10	12	Union Camp Corp. well 10	405–865	9–26–68	19.7	29	.07	.4	.1	104	3.9	226	0	19	24	3.5	.3	2.9	301	0	0	450	8.0	
55B11	13	Union Camp Corp. well 11	380–860	9–26–68	19.6	24	.11	.4	.2	94	3.1	239	0	7.8	7.1	3.5	1.7	2.3	266	0	0	410	8.1	
55B12	14	Union Camp Corp. well 12	385–860	9–27–68	19.0	28	.07	.4	.1	95	3.1	224	0	11	13	3.4	.6	2.6	282	0	0	430	8.2	
55B13	15	Union Camp Corp. well 13	385–865	9–27–68	19.2	23	.03	.6	.2	106	3.9	270	2	10	9.2	2.8	.7	1.8	310	0	0	470	8.3	
55B14	16	Union Camp Corp. well 14	380–865	9–27–68	20.2	31	.05	.8	.2	97	3.1	215	2	15	21	3.0	.4	2.7	294	0	0	440	8.3	
55B15	17	Union Camp Corp. well 15	400–807	9–27–68	19.4	30	.05	.4	.1	90	2.7	218	2	9.4	12	3.0	.2	2.5	275	0	0	400	8.3	
55B19	18	City of Franklin well 3	335–596	9–24–68	18	24	.05	.4	.1	95	3.5	244	0	6.4	3.2	3.4	.4	2.7	278	0	0	415	8.2	
55B20	19	City of Franklin well 4	238–582	10–8–68	17.8	22	.10	.2	.2	143	7.8	305	0	16	29	2.9	.4	2.6	384	2	0	665	8.0	
55B21	20	City of Franklin well 5	450–610	9–24–68	18.5	22	.05	.8	.1	85	3.5	223	0	5.8	2.6	3.5	.6	2.4	249	0	0	360	8.1	
55B23	21	Hercules Inc. well 1	386–586	10–9–68	17.9	29	.03	.2	.1	110	5.9	214	0	17	34	2.7	.2	3.6	318	1	0	535	8.0	
55B36	22	Union Camp Corp. observ. well 2	720–860	7–29–69	20	17	.62	2.3	.6	366	22	438	0	187	195	.8	.1	1.6	1,015	8	0	1,700	7.8	
55B45	23	R.J. Goodrich	338–348	9–22–70	...	11	.02	6.0	2.2	100	8.0	268	0	5.8	24	1.8	.0	.19	290	24	0	460	8.0	
56A1	24	Va. Bur. Water Control Mgt. observ. well 47	989–994	6–22–72	...	31	.30	14	11	1,300	30	620	0	400	1,300	.6	.2	.10	3,600	80	0	6,000	8.1	
56C1	25	Zuni Presbyterian School	418–434	8–25–69	...	23	.08	1.2	.2	101	11	288	0	3.6	3.2	.9	.3	.16	294	4	0	430	7.6	
57A1	26	Va. Dept. of Highways, Whaleville	610–620	10–10–68	17.8	11	.56	2.8	.5	257	16	631	6	16	34	2.5	1.2	.97	650	9	0	1,160	8.3	
57C15	27	City of Norfolk well 2, Lake Prince	546–686	11–28–67	...	30	.08	1.0	.5	208	5.6	506	0	11	21	3.0	1.3	2.1	542	4	0	839	8.0	
58C1	28	Nestle Co. well 1	3546–874	7–31–69	21	24	.75	2.7	.9	313	17	573	0	35	134	2.8	.5	.97	812	11	0	1,368	8.1	
58A2	29	Va. Bur. Water Control Mgt. observ. well 42	1874–1879	7–11–72	...	13	.48	1,100	510	8,800	160	132	0	490	16,000	1.4	1.4	.00	31,410	4,800	4,700	45,000	7.5	

¹Diamond-shaped water-quality diagram.
²Average of two analyses.
³Average of three analyses.

according to the percentage of chemical equivalents of the major cations and anions. Water analyses plotting near the bottom of the diamond represent the sodium bicarbonate water found throughout most of the area; those at the right corner represent the sodium chloride water collected from the lowest sand beds screened in wells 56A1 and 58A2. The alignment of the points suggests that differences in the quality of water are related to the extent to which the fresh sodium bicarbonate water has been mixed with the high sodium chloride water predominant east of the study area and present at the bottom of the aquifer in the southeastern corner of the study area. The analysis of water from well 55B36 and its position on the diagram show that this water is intermediate in composition between the sodium bicarbonate and sodium chloride types.

Present data are inadequate to clearly define the zone, or zones, of high chloride water and its movements. Because movement of water in the Lower Cretaceous aquifer is toward Franklin from all directions, defining the zone and monitoring its movement may become increasingly important to the area's future.

SUMMARY

Water in the Lower Cretaceous aquifer in most of the Franklin area is of excellent quality for domestic, municipal, and most industrial uses. Extensive industrial development of the aquifer at Franklin has created a large regional cone of

depression, which extends in all directions and reaches south into North Carolina. Water levels have declined as much as 185 feet near the center of the cone since 1937–39. Water with relatively high concentrations of chloride is known to be present in the aquifer in the southeastern corner of the study area and to the east. Movement of water in the aquifer is toward Franklin; thus, defining the location and extent of the zone, or zones, of the high chloride water and monitoring its movement would seem to be indicated.

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GROUND-WATER CONDITIONS IN THE FRANKLIN AREA, SOUTHEASTERN VIRGINIA

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